1.5.3 Other Flue Gas Analyses

Other gases sampled for this project include SO_3 and NH_3 slip. SO_3 was measured using the controlled condensation method, and NH_3 slip was measured using Conditional Test Method 27. For most of the sites, SO_3 was measured at the air preheater inlet (SCR outlet) and at the ESP inlet locations. The NH_3 slip was measured at the air preheater inlet.

1.5.4 Mass Balance

At each site coal, hopper ash and, where appropriate, FGD samples were collected and analyzed for Hg. These results, along with flue gas data, were used to quantitatively evaluate the fate of Hg throughout the unit.

1.5.5 Plant Operation Data

Each plant provided operational information, such as plant load and flue gas CEM data, for the purposes of evaluating unit performance and flue gas chemistry. Differences existed between plants regarding the type, frequency, and form in which operational data existed. Therefore, the figures presenting these data are unique to each plant. Nevertheless, the information is useful for comparing Hg SCEM data with plant operational data and evaluating possible impacts on Hg speciation.

2
SITE S2

Site S2 was selected to provide data to determine the impact of catalyst aging on the potential of the SCRs to oxidize Hg.

2.1 Site Description and Configuration

Site S2 fires a high-sulfur Ohio bituminous coal and employs SCR followed by an ESP and a wet FGD. The SCR unit at Site S2 utilizes a Siemens/Westinghouse plate catalyst with a space velocity of 2125 hr^{-1}. Although Site S2 had previously been tested in 2001, there were several operational differences in 2002. To control SO_3 emission, alkali was injected just downstream of the boiler in 2002. Also, a humidification system had been installed upstream of the SCR unit to lower the SCR temperature ~10°F. Finally, the coal may not have been from the same mine as that fired in 2001 as the Cl content in the coal was much less, 520 vs. 1330 ppm. The original intent at Site S2 was to operate 2 weeks with SCR in service and then, following the ozone season, bypass the SCR unit and test without SCR. However, as will be discussed later, there were operational problems at Site S2 that changed this test plan. General information about the configuration of the unit tested at Site 2 are found below:

- Fuel type: Ohio bituminous coal
- Boiler capacity: 1360 megawatts (MW)
- Boiler type: wall-fired
- NO_x control: low-NO_x burner and SCR
- Particulate control: ESP
- SO_2 control: magnesium-enhanced lime FGD

A schematic of Site S2 including sampling locations is shown in Figure 2-1.

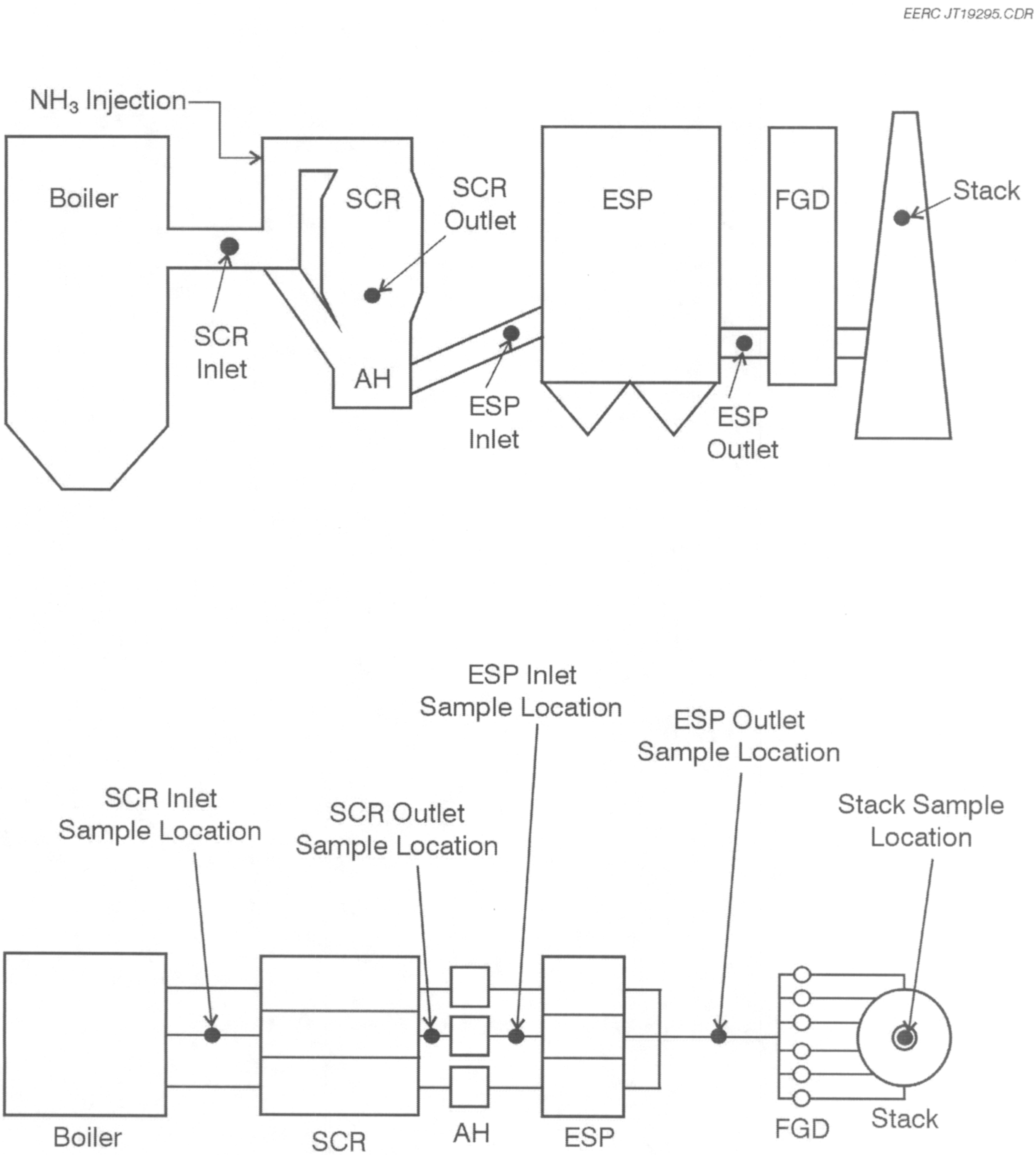

Figure 2-1
Schematic of Site S2 Showing Sample Locations from Horizontal and Vertical Perspectives

2.2 Sampling Approach

The sampling approach at S2 was similar to the previous year and is documented in *Power Plant Evaluation of the Effect of Selective Catalytic Reduction in Mercury* [11]. The objective of testing this unit again in 2002 was to evaluate the effect of catalyst aging on speciated Hg emissions. As stated earlier, changes to the system, including using humidification to operate SCR at a lower temperature, make comparison and interpretation of 2001 and 2002 data difficult. Also, because of operational problems, the SCR unit was bypassed earlier than expected, and the complete test program was not able to be completed. However, Hg SCEM data were collected for approximately 1 month: 2 weeks each with and without SCR on-line.

2.2.1 Flue Gas Sample Streams

Flue gas Hg speciation was measured at five locations using the OH method. Sample locations included the ESP inlet and outlet, SCR inlet and outlet, and stack. A test matrix is provided in Table 2-1. Where practical, OH measurements were conducted simultaneously across the ESP or FGD in an effort to quantify the effect each had on Hg concentration and speciation. In addition to Hg, flue gas samples were also taken to measure the total particulate loading, SO_3 concentrations, and NH_3 slip. The sampling methods used for all the sites are described in Appendix A.

Table 2-1
Sampling Test Matrix for Site S2[a]

Date		SCR In	SCR Out	ESP In	Stack	SCR Out	SCR Out	ESP Out
Begin	End	OH	OH	OH	OH	SO_3	NH_3	NH_3
07/16/02	07/20/02	3	3	2	2	3	2	2

[a] All samples were done with the SCR in service.

Longer-term Hg monitoring was planned using two Hg SCEMs (Tekran): one located at the ESP inlet and the other at the ESP outlet. However, because of severe plugging of the inertial filter probe early in the test, both instruments were operated at the ESP outlet. One instrument measured total Hg and the other Hg^0.

2.2.2 Other Sample Streams

Samples of coal, fly ash, and FGD materials were collected in an effort to obtain representative operational data related to Hg speciation. These samples were analyzed for total Hg and, along with the flue gas emission data, were used to qualitatively evaluate the fate of Hg throughout the unit.

Coal samples and ESP hopper ash samples were collected each day of the test. The coal samples comprised coal from each coal mill that were pulled from the bunker and analyzed by the plant every 12 hours. The EERC received a split of these samples. The ESP hopper ash samples were taken as a field composite from the hoppers associated with the first field of both the upper and lower ESP. The FGD slurry samples were collected from the blowdown tank of the FGD.

2.3 Process Operating Conditions

Plant operational data are presented in Figure 2-2 for Site S2. The most significant change in plant operations is the bypassing of SCR. The amount of NO_x coming out the stack increased significantly (from approximately 50 to 400 ppm) 390 hours into the test period after NH_3 injection was turned off and the SCR unit was bypassed. An increase in Hg^0 was observed with the Hg SCEM and will be discussed later in this report. The average SO_2 collection efficiency of the FGD during the 4-week testing period was 95%, and the NO_x removal efficiency of the SCR unit when in service was 90%.

Average auxiliary flue gas data including moisture, dust loading, and percent carbon dioxide (CO_2) and oxygen (O_2) were collected during the OH sampling from each sample location (Table 2-2). Values are within expected ranges (complete auxiliary flue gas data are provided in Appendix C, Table C-1).

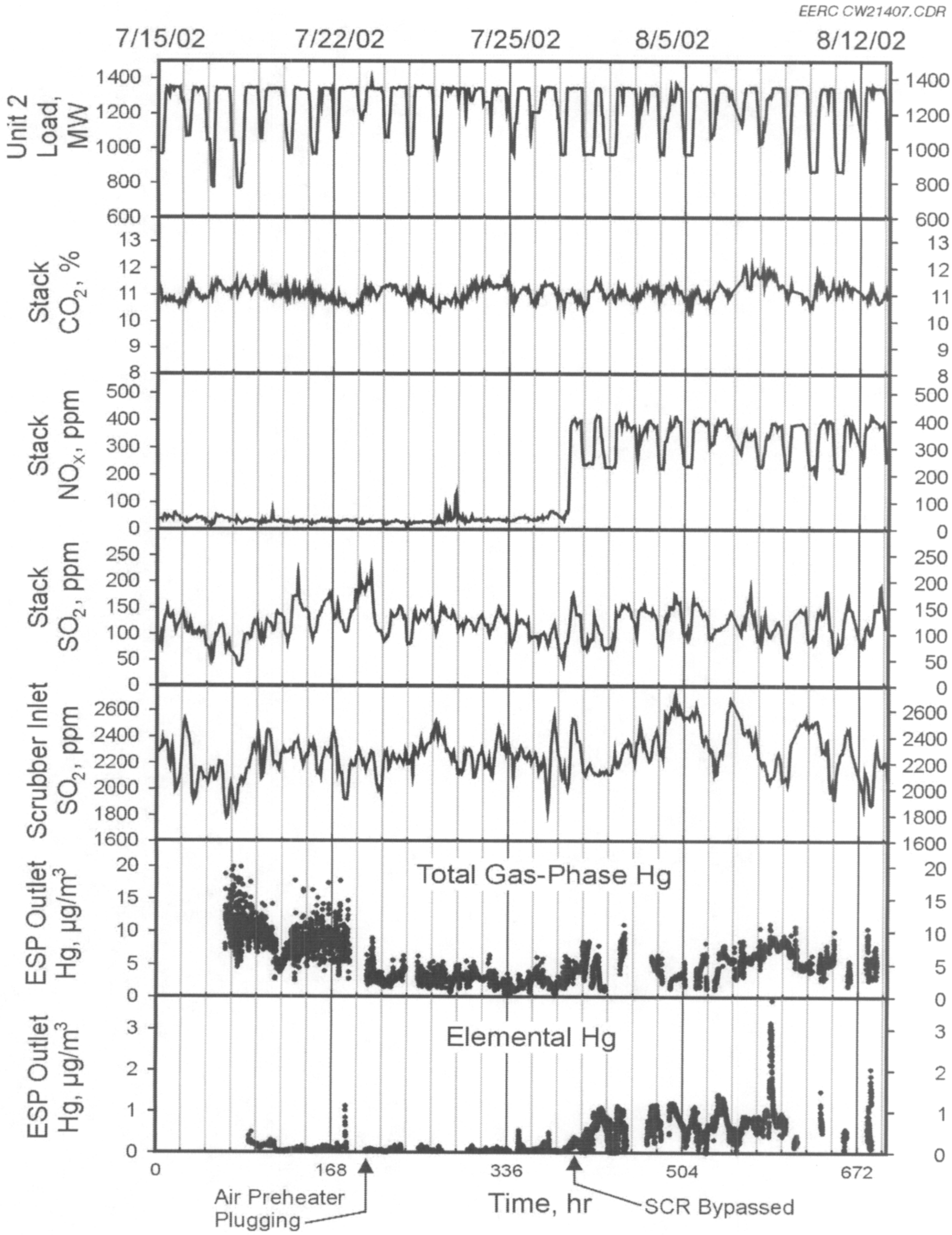

Figure 2-2
Plant Operation Data for Site S2

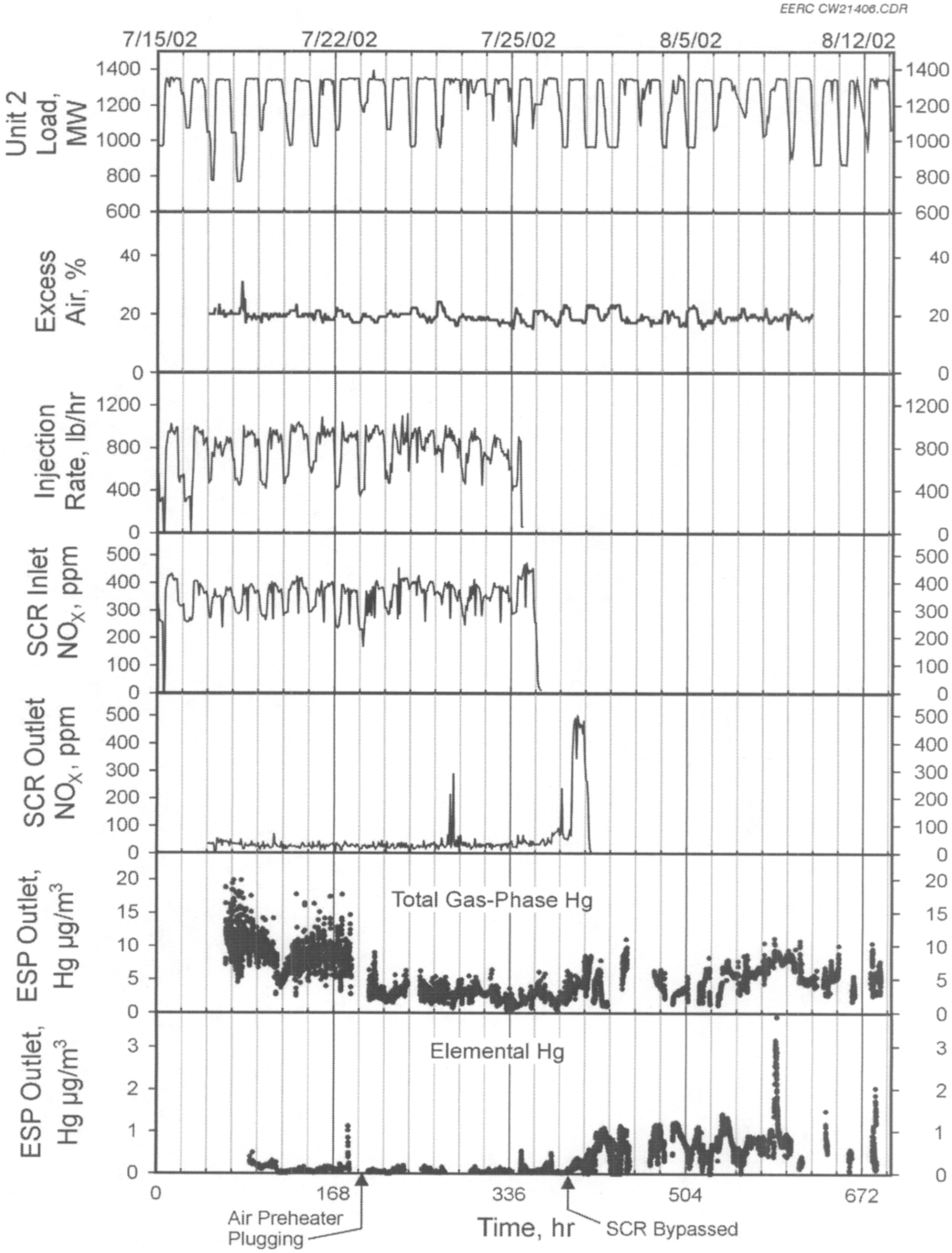

Figure 2-2 (continued)
Plant Operation Data for Site S2

Table 2-2
Average Auxiliary Flue Gas Data for Site S2[a]

Date	Flue Gas Moisture, %	Dust Loading,[a] gr/dscf	CO_2, %	O_2, %
SCR Inlet	9.8	2.7803	15.0	3.8
SCR Outlet	10.8	3.3547	14.8	4.6
ESP Inlet	11.3	1.8872	13.9	5.7
ESP Outlet	11.0	0.0021	13.7	5.8
Stack	21.9	0.0016	13.2	6.5

[a] Dust loadings were collected as part of the OH method using EPA Method 17 and, therefore, are not for compliance purposes.

2.4 Sampling Results

2.4.1 OH Flue Gas Mercury Results

Average Hg results for flue gas sampling at Site S2 are presented in Table 2-3. The complete results are present in Appendix B (Table B-1). As shown in Table 2-3, there was an increase from 54% to 87% in Hg^{2+} across the SCR catalyst. This then increased to 97% at the ESP inlet. Total Hg removal was 84%.

Table 2-3
OH Average and Percentage of Total Mercury Results for S2[a]

	Average, $\mu g/Nm^3$				Percent of Total, %		
Sample Location	Hg_p	Hg^{2+}	Hg^0	Hg_{Total}	Hg_p	Hg^{2+}	Hg^0
SCR Inlet	0.04	6.5	5.5	12.0	0.4	54	46
SCR Outlet	0.06	10.8	1.6	12.4	0.5	87	13
ESP Inlet	0.03	12.2	0.3	12.6	0.2	97	3
ESP Outlet	0.00	11.1	0.3	11.5	0.0	97	3
Stack	0.00	0.7	1.3	2.0	0.2	35	65
Total Mercury Removal = 84%[b]							

[a] Hg values are dry and corrected to 3% O_2.
[b] Total Hg removal is defined as: [(ESP Inlet – Stack)/ESP Inlet] × 100%.

A comparison of the 2001 and 2002 results at Site S2 is shown in Figure 2-3. As shown, in 2001 there was an increase from 48% to 91% Hg^{2+} across the SCR catalyst, which is a larger change than seen in 2002. It is unknown whether this decrease in Hg oxidation across the SCR catalyst is

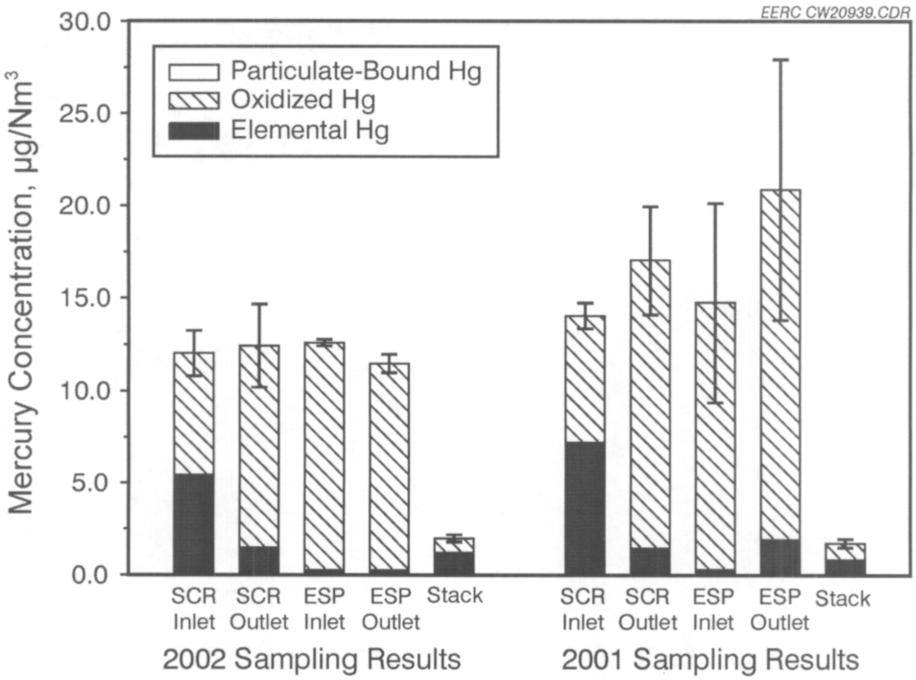

Figure 2-3
Comparison of Mercury Speciation Results 2001 and 2002 for Site S2

a result of operating the SCR unit over an additional ozone season or due to the modifications that were made for SO_3 mitigation or changes in the coal in 2002.

Although there was a decrease in Hg oxidation across the catalyst, there was no change from 2001 to 2002 in the percentage of Hg^{2+} at the ESP inlet location (97% for both years). There was a small decrease in total Hg removal: 89% in 2001 compared to 84% in 2002.

As stated earlier, several operational problems occurred at the plant during the test. Approximately midway through the test period, an increase in pressure drop was measured across the center air heater. To prevent plugging of the air heater, the economizer outlet temperature was raised, and flow through the center air heater was greatly reduced. This eventually required the bypassing of the SCR unit earlier than expected and the load reduced. Therefore, no OH data were obtained in 2002 with SCR bypassed. However, in 2001, the total Hg removal efficiency was only 51% with SCR bypassed.

Although the Hg^{2+} concentration at the inlet to the wet FGD (outlet of the ESP) was 97%, only 84% of the Hg was captured by the wet FGD. This appeared to be a result of an increase in Hg^0 at the stack, from 0.3 to 1.3 $\mu g/Nm^3$.

2.4.2 Hg SCEM Results

Two Hg SCEMs were operated at the ESP outlet to gather longer-term variability data. In the original test plan, one Hg SCEM was to be operated at the ESP inlet and one at the ESP outlet. However, because of flue gas chemistry and particulate loading there was severe plugging of the inertial filter probe so that it was not possible to maintain Hg SCEM operation at the ESP inlet location. Therefore, the two instruments were operated at the ESP outlet location and configured to operate such that one instrument measured total Hg and the second measured Hg^0 continuously. With the exception of occasional maintenance routines and troubleshooting, data for both total Hg and Hg^0 were collected during the entire sampling period. A summary of the Hg SCEM data is provided in Figure 2-4. As shown in Figure 2-4, there is good agreement between the Hg SCEM data and the OH data.

It should also be noted that a high amount of variability was observed, especially during the first several days for total Hg concentration. This may be due to continuously switching between measurement of Hg^0 and total gas-phase Hg during that period as only one Hg SCEM instrument was monitoring the ESP outlet location for the first 198 hours of the test. The variability of the data reduced noticeably after this period when both instruments were used to monitor each Hg species.

The SCR unit was bypassed midway through the test. Table 2-4 shows the statistical variation of the Hg SCEM data with and without SCR in service. Based on the Hg SCEM, there was an increase in Hg^0 when SCR was bypassed. The concentration of Hg^0 appears to have increased from <0.25 $\mu g/m^3$ to ~1 $\mu g/m^3$ after the SCR unit was bypassed. In Figure 2-5, the percentage of Hg^{2+} as determined using the Hg SCEM (total Hg $-Hg^0$) is plotted. When the SCR unit is bypassed, the percentage of Hg^{2+} in the flue gas is reduced and appears to become much more variable.

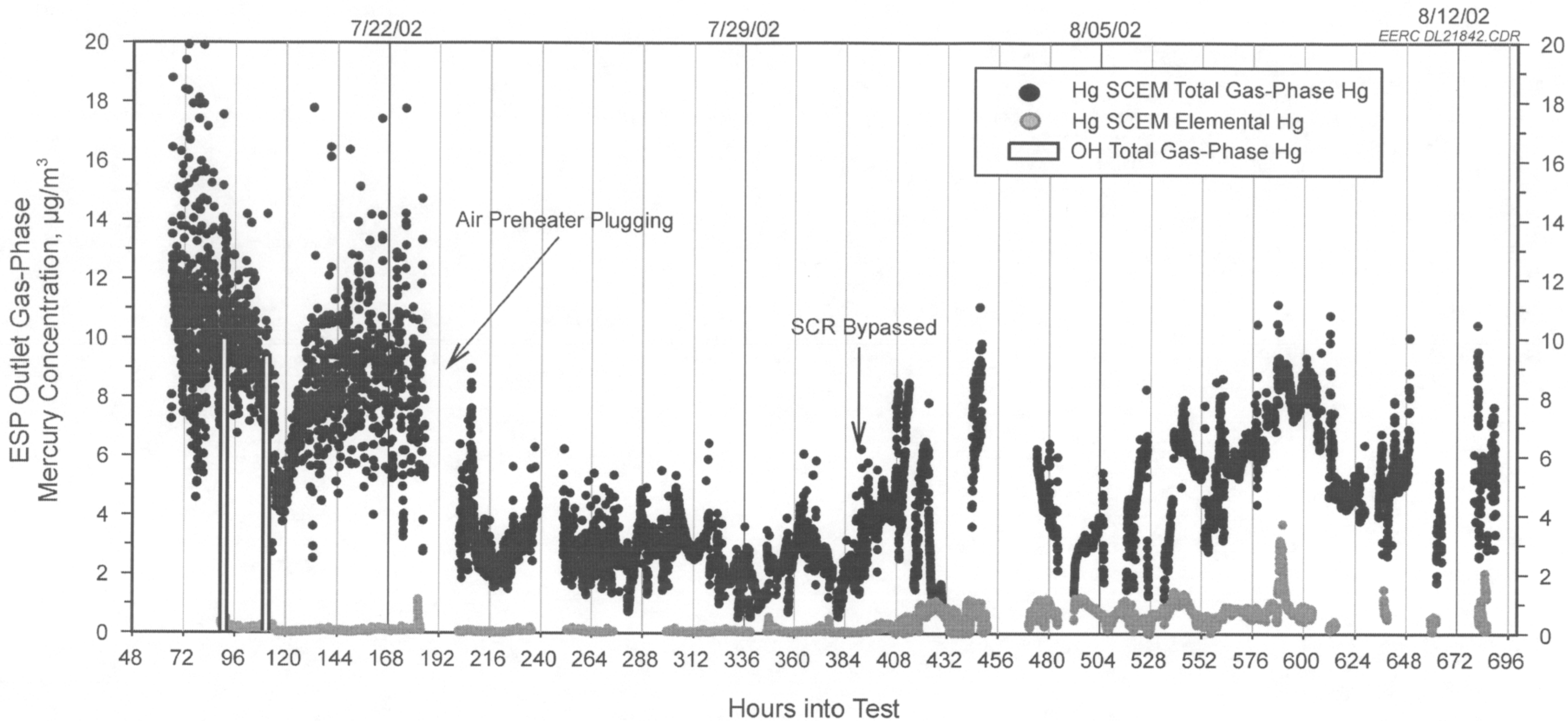

Figure 2-4
Hg SCEM Results for Site S2

Table 2-4
Statistical Variation of the Mercury with and Without the SCR in Service Based on the Hg SCEM Data for Site S2

Mercury	Operation	Average, $\mu g/m^3$	Std. Dev., $\mu g/m^3$	Upper 90% CI,[a] $\mu g/m^3$	Lower 90% CI, $\mu g/m^3$
Hg(total)	With SCR	4.7	3.4	10.3	0.0
Hg^0	With SCR	0.1	0.1	0.3	0.0
Hg(total)	SCR bypassed	6.1	2.0	9.4	2.8
Hg^0	SCR bypassed	0.8	0.5	1.6	0.0

[a] Confidence interval.

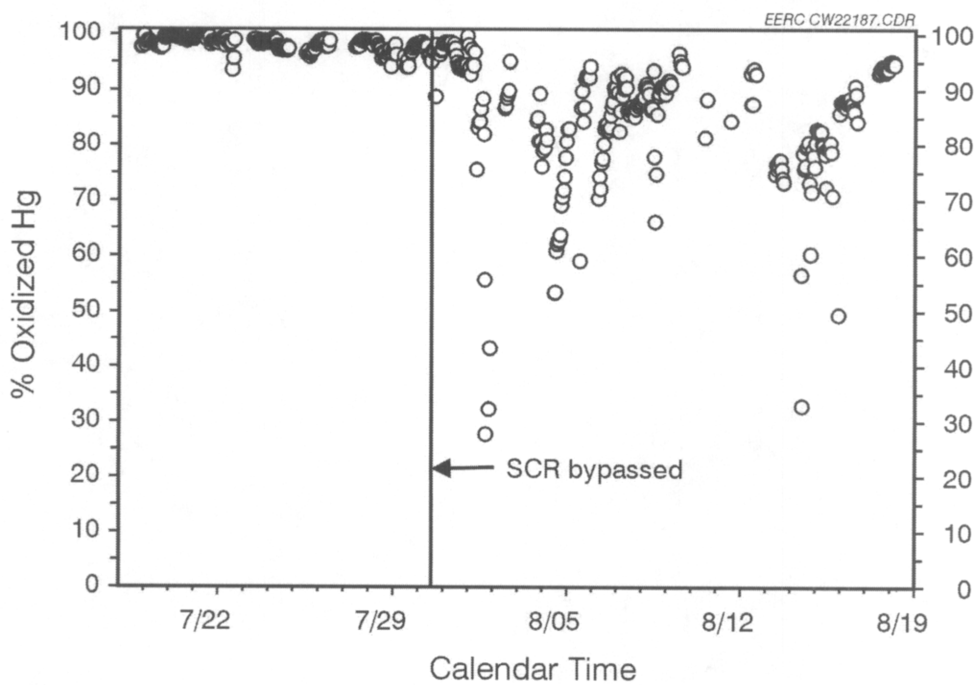

Figure 2-5
Average Hg^{2+} as Measured by Hg SCEMs (total Hg – Hg^0) for Site S2

2.4.3 Coal Analysis Results

In an attempt to understand the Hg variability observed at Site S2, all of the coal samples (45 coal samples) from Site S2 were analyzed by WE Energies and the EERC for Hg and chloride content. The complete data set is presented in Appendix B, Table B-2. The average Hg concentration and chloride content of the coal were relatively constant during the 4-week test period. The Hg concentration was 0.12 ± 0.02 $\mu g/g$, and the chloride content was 636 ± 44 ppm. Both values are similar to those collected during the previous year's sampling. Table 2-5 presents the proximate and ultimate analyses for the period during which the OH sampling was done.

Table 2-5
Coal Analysis for Site S2[a]

Date		7/17/02	7/18/02	7/19/02	7/20/02	Avg.
Mercury	ppm (dry)	0.13	0.11	0.11	0.13	0.12
Chlorine	ppm (dry)	724	605	593	609	632
Proximate Analysis						
Moisture	wt%	5.6	5.4	6.7	6.8	6.1
Volatile Matter	wt%	39.0	39.7	39.8	40.2	39.7
Fixed Carbon	wt%	46.5	45.0	44.1	43.8	44.8
Ash	wt%	8.9	9.9	9.5	9.2	9.4
Ultimate Analysis						
Hydrogen	wt%	5.4	5.4	5.4	5.4	5.4
Carbon	wt%	69.6	68.3	66.5	66.8	67.8
Nitrogen	wt%	1.5	1.4	1.3	1.3	1.4
Sulfur	wt%	3.6	4.0	4.0	3.8	3.9
Oxygen	wt%	11.0	11.0	13.3	13.5	12.2
Heating Value	Btu/lb	12,438	12,070	11,938	11,940	12,097
F_d Factor[b]	dscf/10^6 Btu	9915	10,069	9860	9876	9930

[a] Except where stated, all results are on an as-received basis.
[b] As defined in EPA Method 19.

2.4.4 ESP Ash and FGD Mercury Results

ESP hopper ash samples were collected daily as a field composite of ash from hoppers associated with the first field of both the upper and lower ESP. These samples were analyzed for Hg and loss on ignition (LOI). The FGD samples were filtered, and the liquid and solid fractions both analyzed for Hg. A summary of the analysis of the ESP hopper ash and FGD samples is provided in Table 2-6.

The average Hg concentration in the ESP hopper ash was low, 0.05 μg/g. This is consistent with the particulate-bound Hg measured in the flue gas at the ESP inlet. The LOI was also very low, 0.8%. One factor which may impact the ability of a fly ash to adsorb Hg is the carbon content of the ash. Although not directly measured, the very low LOI indicates low carbon content in the ash. Both the Hg and LOI results are consistent with the data obtained in 2001. For the FGD samples, the average Hg concentration was 0.15 μg/g.

Table 2-6
Analysis of ESP Hopper Ash and FGD Material for Site S2

	ESP Hopper Ash			
Date	**Hg, μg/g**	**LOI, %**	**Hg in FGD Material, μg/g**	**Solids, %**
7/16/02	0.025	0.97		
7/17/02	0.034	0.51	0.16	17.3
7/18/02	0.072	1.15	0.14	18.5
7/19/02	0.032	0.68	0.16	16.5
7/22/02	0.049	0.71		
7/23/02	0.140	1.16	0.12	16.0
Average	0.059	0.86	0.15	17.1

2.4.5 NH_3 Slip and SO_3 Flue Gas Results

NH_3 slip testing was conducted at the SCR and ESP outlets and the SO_3 testing at the SCR outlet location. A summary of these results is provided in Table 2-7. The NH_3 slip concentrations were low, less than 1 ppm. In general, low NH_3 slip values are representative of an efficiently performing SCR.

Table 2-7
NH_3 Slip and SO_3 Results at Site S2[a]

	NH_3 Slip, ppm		SO_3, ppm
Date	**SCR Outlet**	**ESP Outlet**	**SCR Outlet**
07/16/02	0.48		
07/17/02	0.47		30.2
07/18/02			983[b]
07/19/02			1141[b]
07/20/02		0.52	
07/20/02		0.56	

[a] Dry and 3% O_2.
[b] These two values appear to be outliers.

Unfortunately, there appears to be some contamination in two of the SO_3 values. It is unlikely that the SO_3 concentration in the flue gas is greater than 900 ppm. A careful review of the procedures, sample sheets, and analysis did not provide an obvious explanation. One data point

(30.2 ppm) from the SCR outlet was similar to data collected from 2001 and is consistent with expected values. The average ESP outlet SO_3 value in 2001 was 33.2 ppm.

2.5 Mercury Mass Balance

The average ESP hopper ash results were compared with flue gas Hg measurements from the ESP inlet and outlet to determine the Hg mass balance across the ESP. The sum of the ESP hopper ash (in $\mu g/Nm^3$ of flue gas as calculated from the dust loading) and the ESP outlet Hg concentration divided by the ESP inlet Hg concentration results in a balance of 94% (from Table 2-3).

To compare the available Hg in the coal to flue gas measurements, emission factors (F_d factors) as calculated using EPA Method 19 were used to estimate the coal-based Hg concentration. Using the average coal Hg concentration and F_d factors results in a flue gas concentration of 10.9 lb/10^{12} Btu. This compares to a flue gas Hg measurement at the ESP inlet of 9.1 lb/10^{12} Btu, giving a balance of 83%.

The plant did not provide information as to the rate at which FGD material was produced. Therefore, it is not possible to do a mass balance around the wet FGD. However, using the F_d factors, the flue gas Hg measurements at the stack averaged 1.43 lb/10^{12} Btu which corresponds to a removal of 87% (based on the coal Hg) compared to a measured Hg removal of 84%.

2.6 General Observations from S2

- There was increased Hg oxidation across the SCR catalyst as the percentage of Hg^{2+} in the flue gas increased from 54% to 87%. At the ESP inlet and outlet location, the percentage of Hg^{2+} was 97%.
- Comparing the 2002 results with those obtained in 2001 indicated a small decrease in the Hg oxidation across the SCR catalyst. In 2001, there was an increase from 48% to 91% in Hg^{2+} compared to an increase from 54% to 87% in 2002. It is unknown if this is due to a catalyst-aging effect, changes in the operation of the SCR unit (lower temperature), or the addition of alkali upstream of the SCR unit. Although there was a slight decrease in Hg oxidation across the catalyst, the percentage of Hg^{2+} at the ESP inlet location was the same in 2002 and 2001: 97%. The overall Hg removal at Site S2 averaged 84% in 2002 compared to 87% in 2001.
- There appeared to be some reemission of Hg across the wet FGD. The Hg^0 increased from 0.3 $\mu g/Nm^3$ at the inlet to the wet FGD to 1.3 $\mu g/Nm^3$ at the stack. However, this is within the variability of the data.
- Operational changes during the month resulted in data variability; however, those fluctuations resulted from acknowledged changes in system operation and do not represent steady state.
- OH results correlated well with Hg SCEM data and were consistent with repeated samples.
- Very little, if any, Hg was removed across the ESP.

3
SITE S4

Site S4 was selected to provide data to determine the impact of catalyst aging on the potential of the SCR units to oxidize Hg. The mercury sampling and analysis at this site was conducted by Western Kentucky University and was sponsored by EPRI and the host utility.

3.1 Site Description and Configuration

Site S4 is a cyclone boiler that fires a Kentucky bituminous coal and employs SCR followed by a combined particulate/SO_2 venturi/spray tower scrubber (for purposes of this report, this will be referred to as a venturi scrubber). The venturi scrubber has a total of six modules. The system achieves a high particulate removal using a venturi to generate very small water droplets that create a high relative velocity between the particle and droplets. Some of the scrubbing slurry containing limestone for SO_2 removal is introduced at the top of the converging venturi section. However, most of the limestone slurry is introduced through conventional spray nozzles attached to three spray headers in the annular spray tower section of the scrubber. The scrubbed gas and entrained droplets enter a separator before the flue gas exits the stack. The spent slurry is discharged to an on-site disposal pond.

The SCR unit at S4 has a space velocity of 2275 hr^{-1} and contains a vanadium/titanium honeycomb catalyst manufactured by Cormetech. The catalyst is spread into three layers in the SCR unit. The NH_3-to-NO_x ratio was specified to be 1.0. The unit is designed to be operated only during the ozone season (May 1–September 30) (To use all the NH_3 on-site, the SCR was operated 15 additional days in 2002 in October). During the remainder of the year, the SCR is bypassed, but continually pressurized with heated ambient air. Prior to testing in 2002, the SCR unit had been operated for approximately two ozone seasons. Flue gas testing was conducted with SCR operating normally and again with SCR bypassed. General information about the unit configuration is below:

- Fuel type: Kentucky bituminous coal
- Boiler capacity: 704 MW gross
- Boiler type: cyclone boiler with overfire air to reduce NO_x
- NO_x control: SCR
- SO_2 and particulate control: combined particulate/SO_2 venturi/spray tower scrubber

A schematic of Site S4, including sample locations, is shown in Figure 3-1.

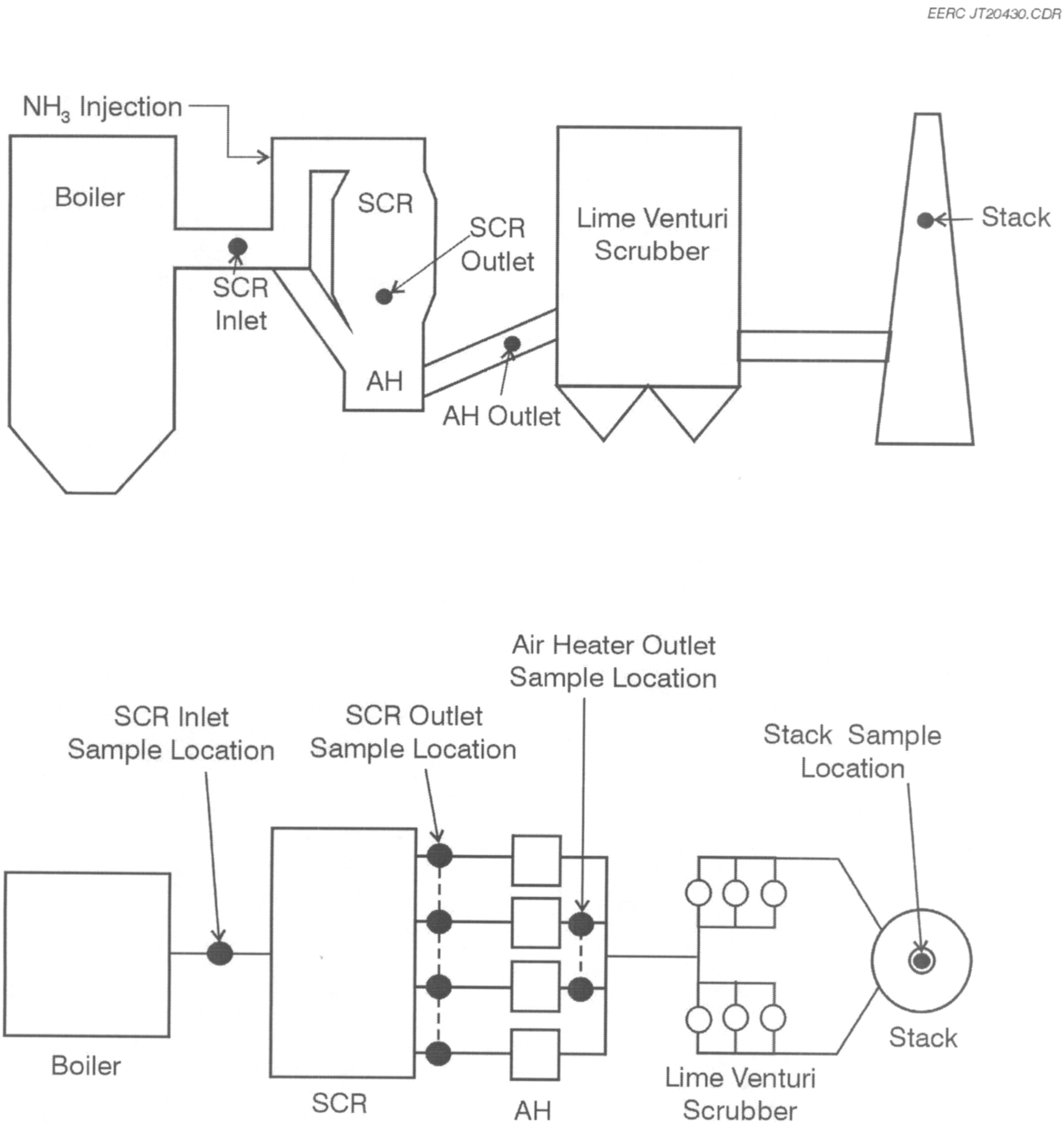

Figure 3-1
Schematic of Site S4 Showing Sample Locations from a Vertical and Horizontal Perspective

3.2 Sampling Approach

Sampling at S4 was conducted similar to testing conducted the previous year and documented in *Power Plant Evaluation of the Effect of Selective Catalytic Reduction in Mercury* [11]. The objective of testing this unit again in 2002 was to evaluate the effect of catalyst aging on speciated Hg emissions.

3.2.1 Flue Gas Sample Streams

With SCR in service, flue gas Hg speciation was measured at four locations using the OH method, the SCR inlet and outlet, the outlet of the air preheater (venturi scrubber inlet), and the stack. With SCR out of service, sampling was only done at the air preheater outlet and stack. These locations are identified in Figure 3-1. A test matrix is provided in Table 3-1. To best quantify the effect SCR and the venturi scrubber had on Hg speciation and concentration, OH measurements were completed as paired sets across each device. In addition to Hg measurements, flue gas sampling was done to measure particulate loading, SO_3 concentration, and NH_3 slip.

Table 3-1
Sampling Test Matrix for Site S4

Date		SCR In	SCR Out	ESP In	Stack	SCR In	SCR Out	SCR Out
Begin	End	OH	OH	OH	OH	SO_3	SO_3	NH_3
With SCR								
09/11/02	09/13/02	3	3	3	3	2	2	2
Without SCR								
10/16/02	10/17/02			3	3			

Longer-term Hg monitoring was conducted using an Hg SCEM (PSA) located at the air heater outlet (same as the venturi scrubber inlet) location. Except for periods of maintenance and when the unit was down, the Hg SCEM was operated around the clock for the duration of the project.

3.2.2 Other Sample Streams

To determine the fate of Hg throughout the unit, samples of coal and venturi scrubber slurry were taken and analyzed for total Hg. A coal sample, taken from the coal yard, was associated with each day of OH sampling. The venturi scrubber samples were taken as the slurry was drained to the settling tank.

3.3 Process Operating Conditions

Plant operational data are presented in Figure 3-2 for Site S4. It should be noted, with the exception of load and boiler O_2 data, the operational data were only collected by the plant during the period when the OH sampling was conducted (beginning and end of test). As the figure shows, the operation at Site S4 during this test program was representative of normal daily operation at or near full load, and there was little variation in the 45 days of the test program, excluding when the unit was down for 3 days. The NO_x removal efficiency for the SCR unit averaged 87%.

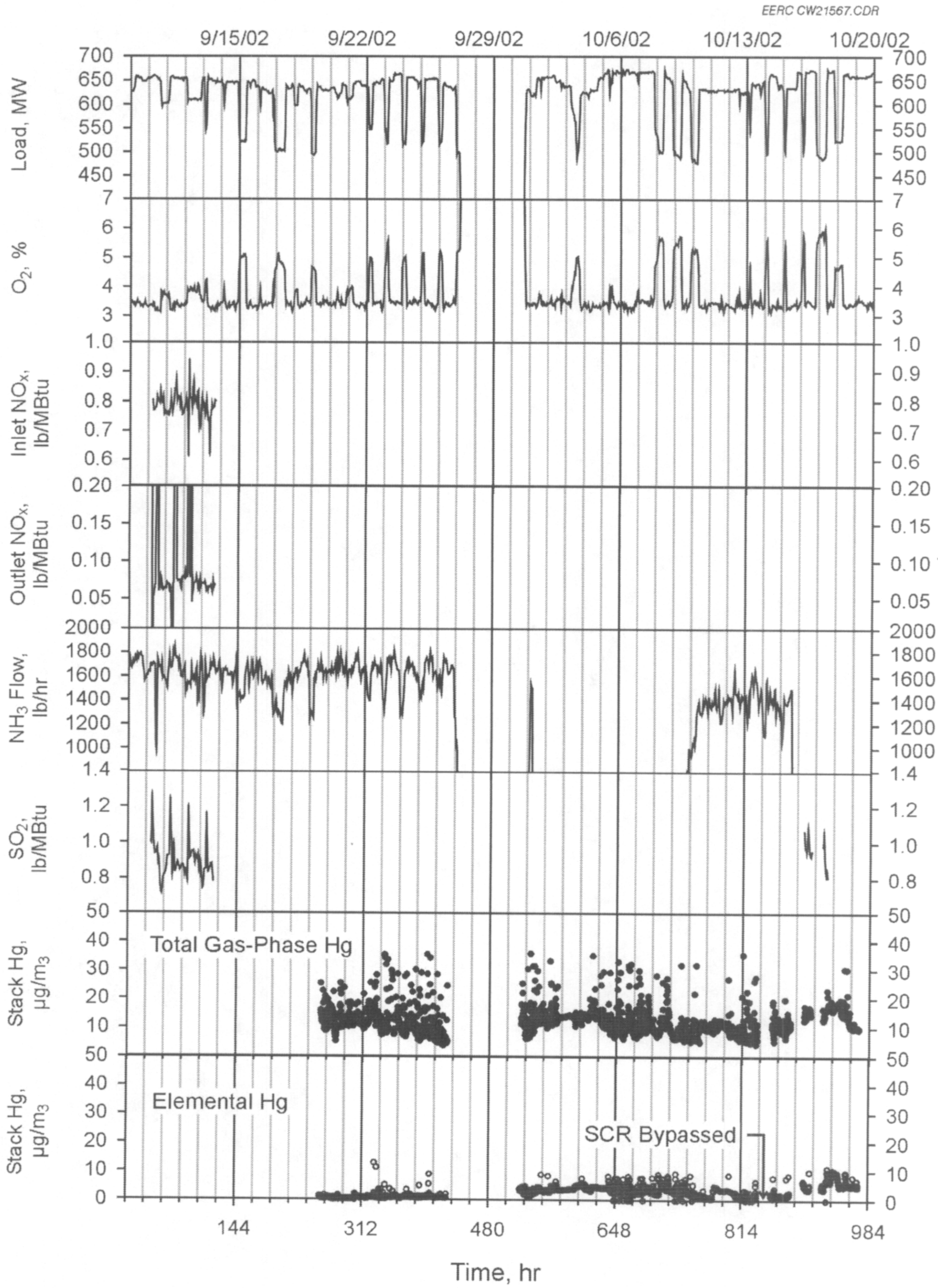

Figure 3-2
Plant Operation Data for Site S4 (note the plant logged some of the data, i.e., SCR inlet and outlet NO$_x$, only when the OH samples were being done)

The average auxiliary flue gas data for Site S4 are shown in Table 3-2. The complete data set is shown in Appendix C, Table C-2. The excess O_2 at the boiler exit was 3.7% ± 0.8% over the entire sampling period of 45 days. However, as is typical at most power plants, there is a substantial air leak across the air preheater. Based on the measured O_2 at the air heater outlet/ venturi scrubber inlet, the average excess O_2 was 7.2%. The air leakage across the SCR and venturi scrubber was minimal. The particulate removal efficiency of the venturi scrubber is high, >99.9%.

Table 3-2
Average Auxiliary Flue Gas Data for Site S4[a]

Date	Flue Gas Moisture, %	Dust Loading,[a] gr/dscf	CO_2, %	O_2, %
With SCR in Service				
SCR Inlet	10.2	1.93	15.0	3.9
SCR Outlet	9.5	1.39	14.9	3.9
Air Preheater Outlet	8.7	1.10	9.0	10.7
Stack	15.2	0.00[b]	11.4	7.8
With SCR Bypassed				
Air Preheater Outlet	9.1	1.24	11.1	7.9
Stack	14.0	0.01[b]	11.1	7.9

[a] Dust loadings were collected as part of the OH method using EPA Method 17 and, therefore, are not for compliance purposes.
[b] Measured to only two significant digits (1/100 of a gram).

3.4 Sampling Results

3.4.1 OH Flue Gas Mercury Results

The Hg results for Site S4 with the averages and percentage of each species are shown in Table 3-3. The complete OH results for Site S4 are shown in Appendix B, Tables B-3 and B-4. Figure 3-3 shows a comparison of the data with SCR in service and with the SCR unit bypassed. As shown in Table 3-3, significant oxidation occurs across the SCR catalyst, from 33% Hg^{2+} to 63% Hg^{2+}. The percentage of Hg^{2+} is further increased to 96% at the outlet of the air preheater. The overall Hg removal is 91% when SCR is in service compared to only 44% when the SCR unit is bypassed.

A comparison of the 2001 and 2002 results at Site S4 is shown in Figure 3-4. As can be seen in the figure, there was a decrease in the oxidation across the SCR catalyst in 2002. In 2001, the concentration of Hg^{2+} as a percentage of total Hg increased from 9% to 80% across the SCR catalyst. This is compared to only 33% to 63% in 2002. However, there is no significant difference between 2001 and 2002 results as measured at the air preheater outlet location; also,

Table 3-3
Average OH Mercury and Results for Site S4

Sample Location	Average OH Hg Results				Percent of Total Hg, %		
	Hg_p	Hg^{2+}	Hg^0	Hg(total)	Hg_p	Hg^{2+}	Hg^0
With SCR in Service							
SCR Inlet	0.05	4.0	8.3	12.3	0	33	67
SCR Outlet	0.00	7.1	4.3	11.4	0	63	37
AH Outlet	0.06	11.3	0.5	11.8	0	96	4
Stack	—	0.3	0.8	1.1	—	27	73
Total Mercury Removal = 91%							
With SCR Bypassed							
AH Outlet	0.08	7.7	5.6	13.4	1	57	42
Stack	NV	0.5	7.1	7.5	—	7	93
Total Mercury Removal = 44%							

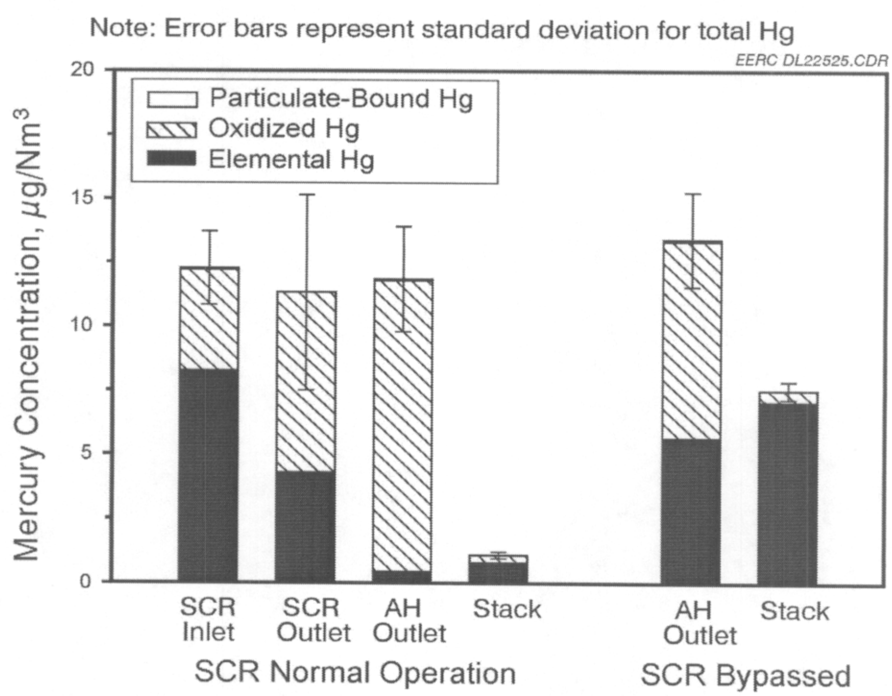

Figure 3-3
Comparison of Mercury Speciation Results with the SCR in Service and with the SCR Bypassed

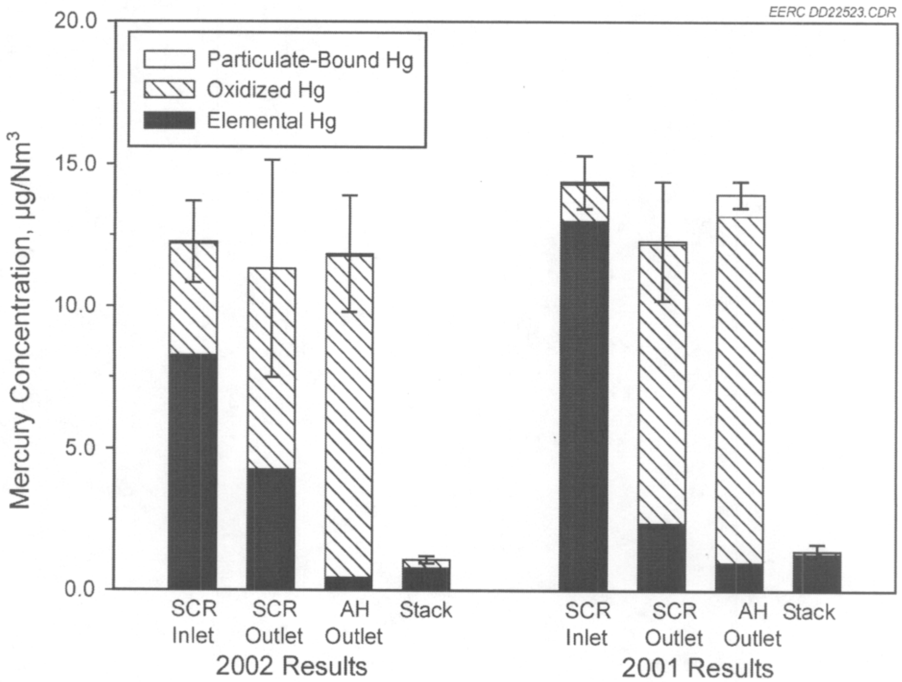

Figure 3-4
Comparison of Mercury Speciation Results 2001 and 2002 for Site S4

the overall Hg removal was the same in 2002 as compared to 2001: 91% compared to 90%. There is some question whether the decrease in Hg oxidation across the catalyst is due to catalyst aging or some other factor. As will be discussed later in this section, the chloride content of the coal appeared to vary considerably in 2001 and was more consistent in 2002. This variation may have affected the Hg oxidation across the SCR catalyst.

As discussed in Section 2.4.1 (Site S2), it appears that Hg reemission can occur across a wet FGD system. At Site S4, there is an increase in the concentration of Hg^0 across the venturi scrubber; however, it is very small (0.5 to 0.8 $\mu g/Nm^3$) and is within the variation of the data. This is discussed in more detail in Section 6.4.

3.4.2 Hg SCEM Results

A Hg SCEM was operated at the air heater outlet location at Site S4. In an effort to gather longer-term data, the Hg CEM was operated nearly continuously for the duration of the project, except when the boiler was down (the Hg SCEM was operated to alternate between total Hg and Hg^0). A summary of Hg SCEM data plotted over the entire test period is provided in Figure 3-5. There is significant variability in both the total Hg and Hg^0 data. Table 3-4 shows the statistical variation of the SCEM data with and without SCR in service. Based on the Hg SCEM data, there was an increase in the average Hg^0 when the SCR unit was bypassed at about 880 hours into the test, from 2.26 to 6.3 $\mu g/m^3$. In Figure 3-6, the percentage of Hg^{2+} as determined using the Hg SCEM (total Hg – Hg^0) is plotted. Figure 3-2 clearly shows substantial Hg^{2+} variability.